A Navigation Tool for Blind People

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***Abstract*-This paper describes the development of a navigation aid in order to assist blind and visually impaired people to navigate easily, safely and to detect any obstacles. The system is based on a microcontroller with synthetic speech output. In addition, it consists of two vibrators, two ultrasonic sensors mounted on the user's shoulders and another one integrated into the cane. This aid is able to give information to the blind about urban walking routes and to provide real-time information on the distance of over-hanging obstacles within six meters along the travel path ahead of the user. The suggested system consists then in sensing the surrounding environment via sonar sensors and sending vibro-tactile feedback to the user of the position of the closest obstacles in range. For the ultrasonic cane, it is used to detect any obstacle on the ground.**

I. INTRODUCTION

Mobility is one of the main problems encountered by the blind in their daily life. Over time, blind and visually impaired people have used some methods and devices, such as the long white cane and guide dog, to aid in mobility and to increase safe and independent travel. Due to the development of modern technologies, many different types of devices[1] are now available to assist the blind to navigate. There are commonly known as electronic travel aids. Among these aids are Sonic Pathfinder [2], Mowat- Sensor [3], and Guide-Cane [4] which are called clear path indicators or obstacle detectors since the blind can only know whether there is an obstacle in the path ahead [5]. These devices are used to search for obstacles in front of the blind person, and they operate in a manner similar to a flashlight, which has very narrow directivity. Sonic-Guide[6] and NavBelt [7], however, are called an environment sensor since it has wide directivity enabling it to search for several obstacles at the same time.

The purpose of this project was to create a prototype of a device that can help blind people to travel with increased independence, safety, and confidence.

The proposed system involves a microcontroller with speech output. It is a self contained portable electronic unit. It can supply the blind person with assistance about walking routes by using spoken words to point out what decisions to make.

In addition, and in order to overcome the imperfections of existing electronic travel aids, the suggested method of measuring distance travelled in this system, is to use the acceleration of a moving body which in this case is the blind person. An accelerometer, followed by two integrators is used to measure a distance travelled by the blind. This technique is considered in inertial navigation systems [8] and suffers from drift problems caused by the double integration and offset of the accelerometer which are overcome by the footswitch [9]. When this footswitch is closed, the acceleration and the velocity are known to be equal to zero and this can be used to apply a correction.

In order to help blind travellers to navigate safely and quickly among obstacles and other hazards faced by blind pedestrians, an obstacle detection system using ultrasonic sensors and vibrators has been considered in this aid. The proposed system detects then the nearest obstacle via streoscopic sonar system and sends back vibro-tactile feedback to inform the blind about its localization. On the other hand, an ultrasonic cane equipped with wheels is considered to detect any obstacle which may be on the ground.

The system has then an environment recognition and a clear path indicator functions.

II. REQUIREMENTS

Portability, low cost, and above all simplicity of controls are most important factors which govern the practicality and user acceptance of such devices.

The electronic travel aid (ETA) is a kind of portable device. Hence it should be a small-sized and lightweight device to be proper for portability.

The blind is not able to see the display panel, control buttons, or labels. Hence the device should be easy to control: No complex control buttons, switches and display panel should be present. Moreover, the ETA device should be low-price to be used by more blind persons.

Our system is developed for portable (small size and lightweight), inexpensive and easy to use, and low-power consumption (supplied by battery).

III. PRINCIPLE OF OPERATION

The aid consists of a microcontroller as processor, an accelerometer, a footswitch, a speech synthesizer, an hexadecimal keypad, a mode switch, three ultrasonic sensors, two vibrators and a power switch. Fig. 1. shows the block diagram of the system.

T. Sobh (ed.), Innovations and Advanced Techniques in Computer and Information Sciences and Engineering, 333–337.

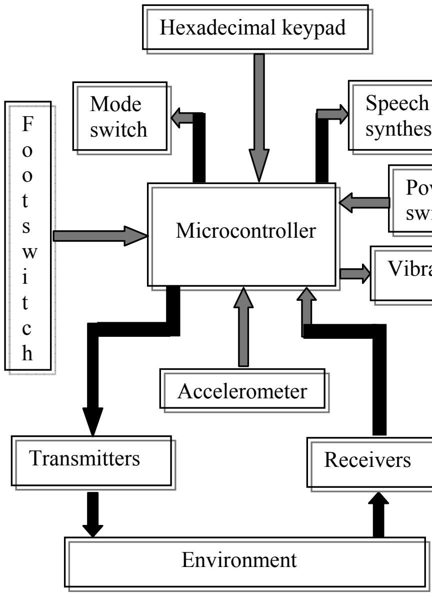

Fig. 1. Block diagram of the system.

The obstacle detection part of the system contains three ultrasonic transmitters-receivers and two vibrators.
Two pairs of these ultrasonic sensors are mounted on the blind's shoulders[10] as shown in fig. 2.

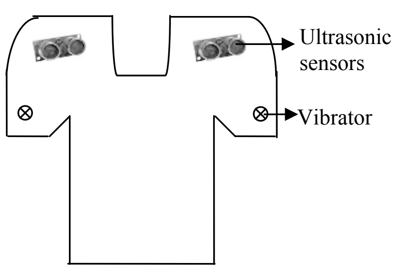

Fig 2. Sonars mounted on shoulders.

The other is cane type subsystem[11] as shown in fig 3. It is equipped with ultrasonic sensors and wheels. The user walks with holding this cane type system in front of him like the white cane. The cane type system notifies whether any obstacle is in the middle of the walking direction. Since the wheels are always contacted with ground, the user can recognize the condition of ground such as depression, cavity, and the stairs with his hand's tactile sensation intuitively.

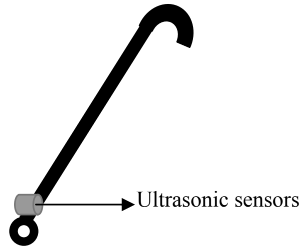

Fig 3. The ultrasonic cane.

This obstacle detection system use a 40 KHz ultrasonic signal to acquire information and can detect the presence of any obstacle within the specified measurement range of approximately 0.03 to 6 meters. It operates by sending out a pulse of ultrasound. Eventually the pulse is reflected from a solid object in the path of the pulse. The time between the outgoing pulse being transmitted and its echo being received corresponds to the distance between the transmitter and the object or the obstacle. This information is then relayed to the blind in some vibro-tactile way and speech way(for the cane).

On the other hand and as the 'Micromap'[12], the system has two modes of operation, record and playback. In addition, the playback mode has two directions, forward and reverse. The user selects then, one of these three possibilities by a switch.

In the record mode, the blind walks the route of interest, and the aid measures the distance travelled by the user. When the blind reaches a decision point, for instance a point at which the route takes a left turn, the user presses a key on the aid coded with a left turn instruction. This has two effects:
- The distance travelled is stored in memory of the ;microcontroller, and the counter reset to zero.
- The left turn instruction is stored.
Afterwards, the blind walks to the next decision point and the above procedure is repeated.

In the playback mode, the aid measures again the distance travelled by the user. When this is equal to that stored in the memory for that particular section of the route, an audible signal is given to the blind. The audible signal is coded to indicate what action the user should take at this point, for instance turn left. In the reverse direction, the procedure is exactly the same except that the route information stored in the memory is used in reverse order, and that right and left are interchanged.

At decisions points, the blind can make any of the following decisions:
Turn right; Turn left; Cross road; Cross road junction; Pedestrian crossing; Steps; Pause; Stop.
Each of these decisions has separate key. There are also two extra keys available, which are undefined in the present software, but which the blind could have available for their specific use.

The system can store a number of routes, each of which is numbered, and be selected using the same set of keys as for